PB83-211094

Nationwide Urban Runoff Program, Austin, Texas
Executive Summary of the Final Report
July 1979-January 1983

Texas Dept. of Water Resources, Austin

Prepared for

Environmental Protection Agency, Washington, DC
Water Planning Div.

Jan 83

U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No. PB83 211094
4. Title and Subtitle: Nationwide Urban Runoff Program, Austin, Texas - Executive Summary of the Final Report			5. Report Date: January 1983 6.
7. Author(s): Frank J. Castaldi, Ph.D., P.E.			8. Performing Organization Rept. No.
9. Performing Organization Name and Address: Texas Department of Water Resources, and City of Austin, Department of Public Works and Engineering, P.O. Box 1088, Austin, Texas 78767			10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G) P-006312-01-0
12. Sponsoring Organization Name and Address: EPA, Office of Water Program Operations, Water Planning Division, 401 M Street, SW, Washington, D.C. 20460			13. Type of Report & Period Covered: Final, July 1979 - Jan. 1983 14.

15. Supplementary Notes

Refer also to Final Report and Appendix H - Public Participation NURP Public Opinion Survey.

16. Abstract (Limit: 200 words)

This Executive Summary briefly describes the study objectives and scope, the study area and historical conditions, data analysis of the stormwater and receiving water quality, the results of a public opinion survey, conclusions, observations and recommendations. Problems limiting the total evaluation are also discussed.

17. Document Analysis a. Descriptors

Hydrology	Water pollution	Storms	Civil Engineering
Urban development	Water resources	Regional planning	
Watersheds	Sedimentation	Urban planning	

b. Identifiers/Open-Ended Terms

Runoff		
Streamflow	Soil Erosion	Storm Drains
Stream pollution	Water Quality	Urbanization
Rainfall	Sediments	Land use
Snowmelt	Sediment Transport	
	Suspended Solids	

c. COSATI Field/Group

18. Availability Statement: No restriction on distribution. Available from National Technical Information Service, Springfield, VA 22161	19. Security Class (This Report): UNCLASSIFIED	21. No. of Pages: 37
	20. Security Class (This Page): UNCLASSIFIED	22. Price

(See ANSI-Z39.18) See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

PB83-211094

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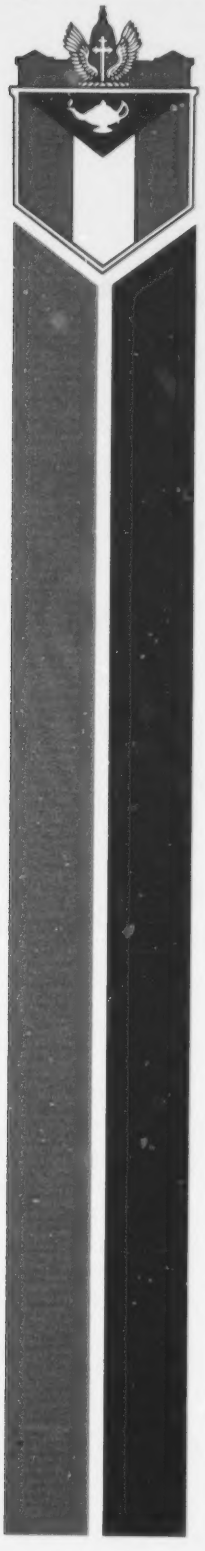

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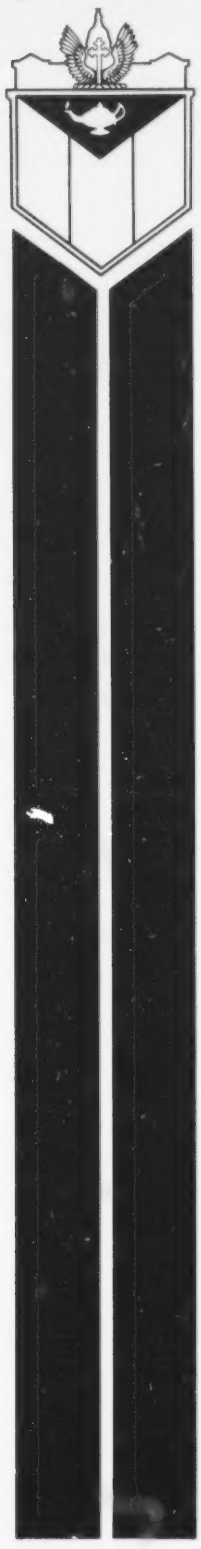

EXECUTIVE SUMMARY OF THE FINAL REPORT
NATIONWIDE URBAN RUNOFF PROGRAM
AUSTIN, TEXAS

AUSTIN NURP STUDY

Executive Summary

Introduction

The Austin NURP Project is one of twenty-eight urban runoff studies which were funded as part of the Environmental Protection Agency's Nationwide Urban Runoff Program (see attached U.S. map. While each of these projects is separate and has specific goals, all have the assessment of the significance of urban runoff impact on water quality, and the evaluation of the overall effectiveness of particular best management practices in protecting urban water quality as their main purposes. They represent an array of varying conditions including regional effects, climatological conditions, land use types, receiving water bodies, water uses and problems, and control approaches.

The general objectives of the Nationwide Urban Runoff Program study were to determine: 1) the extent to which urban runoff is a contributor to water quality problems, as compared to other sources and/or background loads; 2) the nature of urban runoff problems where significant problems have been identified; 3) the causes of these problems; 4) the severity of these problems, based on consideration of beneficial uses and water quality standards; 5) opportunities for controlling urban runoff problems, including descriptions of control measures, their effectiveness, costs and strategies for broad scale implementation; and 6) whether best management practices (BMP) for control of urban runoff are cost-effective in comparison to alternative options. Austin was chosen because the lack of point sources in the vicinity indicated that most pollution is due to urban runoff. Further, there was significant feeling on the part of the populace that current and future impacts of urbanization should be assessed. The study officially began January 31, 1980. After a selection process, Engineering-Science, Inc. was chosen as the City's consultant, with primary responsibility for the performance of the technical aspects of the project.

Objectives of the Austin NURP

The specific, stated objectives of the study were to document the existing impacts of storm loadings on Lake Austin and Town Lake water quality and aquatic ecology, and to quantify the stormwater runoff pollutant loads from selected land use categories with varying degrees of urbanization and to examine a structural control measure in one of the test watersheds.

Scope

A survey was initiated which involved stormwater and receiving water sampling in order to determine the runoff quality and its impact on the lakes. The stormwater study had as its focus the quantification of pollutant loads and the evaluation of the effectiveness of two control measures (one structural and the other nonstructural). The receiving water study was designed to determine if water quality degradation could be detected during and after rainfall runoff, and whether such deterioration could be attributed directly to urban runoff. The receiving water survey consisted of water quality sampling, sediment sampling, and fish tissue analysis.

Description of the study area

Three stormwater sites were monitored: Northwest Hills, Rollingwood and Turkey Creek. These drainage areas were selected based upon distinct differences in the degree of urbanization as indicated by percent of impervious cover and based upon the availability of structural control devices. The Northwest Hills site consisted of two stations, one at the base of Woodhollow Dam and one at Hart Lane. The northwest site was a moderate density residential land use (on sewers) with 39% impervious cover, Rollingwood was low density residential land use (on septic tanks) with 21% impervious cover, and Turkey Creek was essentially undeveloped with less than 2% impervious cover.

Lake Austin has a relatively undeveloped drainage area, whereas Town Lake is the receiving water body for a number of highly urbanized creeks and storm sewers. Flow characteristics are dominated in dry weather by water releases from Lake Austin, and in turn from Lake Travis. The inflows from creeks to Town Lake and Lake Austin are most significant during the fall and winter when Lake Travis releases are at a minimum. The most significant inflows to Town Lake and Lake Austin are Barton Creek and Bull Creek respectively. Station locations are indicated on the Austin area map.

Historical Conditions

A number of agencies have been collecting water quality data for both the lakes: City of Austin Water and Wastewater Department, City/County Health Department, Texas Department of Water Resources, and the U.S. Geological Survey. The USGS has also collected stormwater data for a select number of tributary streams since 1975.

A historical comparison of bacterial pollution after storm events was done on Lake Austin and Town Lake. The results are presented in Tables 9 and 10.* Table 57 is a listing of selected water quality criteria to be used as a comparison with the study results. As can be seen, bacterial concentrations are about 10 times higher on Town Lake than Lake Austin for a given storm, and also tend to increase downstream.

Data Analysis

Stormwater

Stormwater quality and quantity data were collected from February 1981 to November 1981 at the Northwest Hills site, from March to August at Rollingwood, and from May to June at Turkey Creek. Table 21 is a summary of these data. Some of the most important observations which can be made about this data are:

(a) Lead, copper, and zinc were the only heavy metals present in detectable quantities.
(b) Pesticides were not present in detectable quantities.
(c) The median concentration of bacteria was two times higher at the Northwest Hills site than at Rollingwood, and 30 times higher than at Turkey Creek.

*NOTE: All figures and tables are presented in the appendix. The numbers for the figures and tables in this executive summary correspond to those in the Final Report for consistency and ease of reference.

(d) Concentrations of nutrients (nitrate and phosphorous) were similar at the Northwest Hills and Rollingwood sites, but two times higher than Turkey Creek.

In order to estimate pollutant loads, multiple regression equations for predicting stormwater runoff pollutant concentrations for the two test watersheds were developed. An analysis of runoff volumes was made as well. Runoff coefficients were estimated for Northwest and Rollingwood Sites (See Fig. 24). As can be seen, the Northwest Site has a distinctly higher runoff coefficient. It should be noted that all data obtained were for relatively small storms. Specifically, the maximum amount of runoff was .07 inches. The data were analyzed to determine pollutant washoff rates. Estimations of selected pollutant loads are presented in Table 31. The Northwest Hills site produced runoff pollutant loads per acre several times greater than those generated from Rollingwood. Specifically, the nutrients were 2-5 times higher and TSS was approximately 15 times higher. A nomograph has been prepared which shows the relationship between imperviousness, amount of rainfall, total runoff, and pollutant loads for phosphorus and nitrate.

Three storm events were monitored for the effectiveness of the control structure at Woodhollow. Estimates of removal rates were made; unfortunately, three data points are too few to have statistical validity. The results for COD, TOC, NH_3, Total N, Total P, and TSS are given in Table 34.

The results of the priority pollutant analysis are given in Table 39. With the exception of lead, copper, and zinc, the other pollutants were low or not detected. Table 37 shows that the concentrations for heavy metals are all well over two times higher at Northwest than at Rollingwood.

Receiving Waters

Receiving water data were collected under ambient conditions, as well as storm and post-storm conditions in the spring and summer of 1981. Lake Austin was sampled on May 1, 16, and 24, June 11 and July 5, 1981. Town Lake was also sampled on the latter two dates.

The data on ambient water quality are summarized in Tables 40 and 41. As can be seen from these data, ambient water quality conditions are generally quite good.

Storm event-oriented water quality sampling on Town Lake and Lake Austin indicates that the effects of runoff-generated pollutants on receiving water quality can be significant in the short term, although chronic long-term impacts were not apparent in the water column (See Tables 55 and 56).

One set of sediment samples was taken. Lake bottom sediments contained environmentally persistent constituents, such as metals (especially lead and zinc) and chlorinated hydrocarbon pesticides (DDT and its metabolites). Of these, lead and zinc were the only ones detected to any degree in the water column. (See Tables 42 through 44.)

One set of fish samples was taken. Metals, PCB's, and pesticides were found in lake fish samples, but at low concentrations. Some DDT levels were found to be high. (See Tables 45 through 48)

An analysis of water treatment plant costs was performed. The total chemical cost associated with the treatment of water was found to be increased slightly by runoff.

NURP Public Opinion Survey

Prior research has shown that public perception of the "water quality problem" plays an important role. Only if the public perceives a problem, can governments be reasonably expected to take corrective action. As stated in a 1974 water quality survey in Atlanta, the difference between "public perception of the severity of the problem and the tolerable level for the problem serves to drive the system."

In summary, the 1982 survey of attitudes toward water quality in the Austin area reveals that:

1) The water quality problem was considered "serious" or "somewhat of a problem" by a majority of the registered voters for both surface water (68%) and ground water (59%).

2) By a 2:1 ratio, the respondents felt that "development/construction" was the major source of pollution and contributed "a lot" to the problem.

3) The majority of respondents identified either bacteria (30%) or nutrients (22%) as the most significant types of pollution in the Austin area.

4) By a greater than 2:1 ratio, the respondents felt that legal restrictions were preferable to either voluntary compliance or tax and monetary incentives for protecting urban water quality.

5) Approximately 2/3 of the registered voters would be willing to pay $.50 - 1.00 per month for water pollution cleanup.

6) Two to three times as many respondents felt that the polluters, rather than anyone else, should pay with regard to pollution caused by septic systems (59% to 34%) and development/construction (72% to 22%). Pollution from streets was seen to be mainly the responsibility of the utility users (general public).

7) Of the water bodies listed, all were perceived by a majority to be either "very" or "somewhat" polluted. The cleanest was perceived to be Lake Austin; the most polluted, Shoal Creek.

8) 72% of the registered voters use Austin's lakes and creeks to some degree. The one used most often was Lake Travis, followed by Lake Austin. Over half the people either swim or boat, with the primary recreational activity being swimming by a large margin.

One of the important facets of the data dealing with recreational activity was the indication that such a large percentage (56%) of the respondents either swim, ski or fish. Forty-four percent of the respondents participate in some form of contact recreation (36% swim and 8% ski). Twelve percent of the respondents fish in area water bodies, and as such, would have aquatic life concerns.

Even though the vast majority of answers were consistent with the data in the report, there were some discrepancies. There were several areas that the respondents seemed misinformed about: (1) development/ construction was rated as a major problem, yet sedimentation was not perceived as the problem that it is in Austin. (2) Industrial waste discharge was seen as more of a problem than the situation indicates, and this was also true of chemical (toxic) pollution. (3) Barton Springs ranked too high in pollution in terms of what the data warrants, but this is understandable in light of recent newspaper headlines.

Conclusions/Observations

There are two basic assumptions underlying the conclusions of this study: 1) Lake Travis water quality will remain high. Because of the flushing action caused by the Lake Travis release, any degradation in Lake Travis will affect downstream impoundments. 2) Lake releases will remain in effect at current levels. Should they diminish, there will be a corresponding degradation in water quality. With this in mind, the following can be concluded from the data obtained during the Austin NURP study:

(1) The difference in the pollutant mass loads from the two test watersheds, Northwest Austin (medium-density residential) and Rollingwood (low-density residential) were quite distinct. These stormwater runoff data indicate a definite trend toward higher runoff coefficients with an increase in impervious cover. Therefore, the Northwest Austin site produced runoff pollutant loads per acre of surface on the order of 5 to 10 times greater than those generated from the Rollingwood watershed.

(2) Limited stormwater quality data collected from the sparsely developed control watershed (Turkey Creek) indicated that substantially lower pollutant loads are generated from undeveloped areas than are produced from runoff associated with low-to-medium density residential development on land with the natural hydrologic characteristics found in north and west Austin. The quantity of runoff per acre of land area at Turkey Creek was significantly lower than that measured at the other two sites. In addition, peak flow rates at Turkey Creek were significantly attenuated compared to those associated with similar rainfall intensities at the other two sites, and the runoff recession often continued for a number of days after a rainfall event due to storage and release of the water by limestone strata in this area.

(3) Data collected from the Northwest Austin and Rollingwood residential watersheds showed that the concentrations of the pollutants measured in the urban runoff were either variable depending on the type of pollutant, or were not statistically different. It was found that the greater volume of runoff from the higher density residential watershed (Northwest Austin) tends to dilute the greater mass of pollutants washed from this watershed to concentration levels similar to those observed for the low-density residential area. Limited stormwater quality data for the undeveloped Turkey Creek watershed indicate that, of those parameters examined, nitrate, phosphorus, and fecal coliforms were lower than those measured at the urbanized sites. The concentrations of the other parameters were not significantly lower. It can be concluded from these data that the primary factor determining the quality of pollutants in stormwater runoff from the NURP watersheds, with the exception of those pollutants contributed directly by human and animal activities such as nitrates, phosphorus, and coliforms, is the relative area of impervious cover in a particular drainage area.

(4) Significant levels of toxic pollutants were not found in either the stormwater runoff samples collected at the Northwest Austin and Rollingwood sites or the samples collected from the water column in Town Lake and Lake Austin. Moreover, other than the presence of measurable quantities of copper, lead and zinc, only trace levels of insecticides and defoliants were present in the stormwater runoff samples collected from the two test watersheds.

(5) Storm event oriented water quality sampling on Town Lake and Lake Austin indicated that the short-term effects of runoff-generated pollutants (BOD_5, NH_3, TSS, PO_4, fecal coliforms) on receiving water quality can be significant, although chronic water quality impacts were not apparent. Austin NURP monitoring and analysis activities on Town Lake and Lake Austin have produced data which quantify water quality effects that support present concerns regarding the impact of urban runoff on the recreational uses of the lakes. Elevated coliform levels were observed in the lakes in association with runoff periods, and at times exceeded water quality standards for recreational use. In addition, the presence of floatables (i.e., oil and grease and refuse) were observed in the tributaries to the lakes at levels which discourage recreational use. Nevertheless, these data do not suggest that urban runoff has significantly reduced the usefulness (although water treatment costs are increased) of Town Lake or Lake Austin as a potable water source to the City of Austin. The metals, for example, which were present at elevated levels in stormwater runoff, were not detected at hazardous concentrations in the water column of the two lakes. However, survey data indicated that lake bottom sediment samples did contain environmentally persistent constituents (DDT and its breakdown products and

some metals) which were deposited over many years, even though ambient water concentrations for these same constituents were negligible.

(6) Although the use of the chlorinated hydrocarbon pesticide, DDT, has been outlawed for over a decade, it is still present in the bottom sediments of Town Lake and Lake Austin. The principal source of this apparent pollutant load, in this instance, can be related to translocation of the DDT complex by adsorption on sediments which move from adjacent lake bottoms during major storm events. (The dynamics of chlorinated hydrocarbon translocation and bioaccumulation in the aquatic environment, although complex, are susceptible to study.) Approaches to the estimation of rates of input, decay, and translocation can be developed and assessed by continued analysis of such environmental samples as lake bottom sediments and fishes.

(7) The concentrations of metals and chlorinated hydrocarbon pesticides and PCBs measured in the tissues of fish samples collected from both Town Lake and Lake Austin were not at a level considered hazardous to public health except for one of ten DDT analyses. However, since DDT and its breakdown products are potentially carcinogenic, further study into the distribution of this pollutant in the sediments and biota of Lake Austin and Town Lake is recommended.

(8) The total chemical cost associated with the treatment of drinking water was affected by stormwater runoff and subsequent lake water quality. There was an apparent increase in water treatment chemical costs for the production of drinking water which correlated with runoff events when the cumulative rainfall volume was greater than one inch. Part of this increased cost is the result of increases in hardness and alkalinity caused by nonurban storm runoff, however, the bulk of the chemical cost increment is associated with increased consumption of activated carbon and chlorine, for controlling taste and odor and higher bacteria levels. This incremental increase in cost of treatment is small, based on the magnitude of the difference and the small percentage of time during the year that the situation occurs.

(9) Of the pollutants measured, the effects of urban stormwater runoff on Town Lake appear to be more significant than Lake Austin with regard to bacteria in the water column. Differences between the lakes, with regard to other parameters in the water column are inconclusive at this time. Town Lake also appears to be more polluted than Lake Austin in the following areas: bottom sediment analysis (lead, zinc, and DDT) and fish tissue analysis (lead, copper, and DDT).

(10) The public opinion survey signified that there is a very strong interest and generally accurate awareness in water quality issues among the registered voters of Austin. Water pollu-

tion was considered to be a problem by the majority of registered voters, and all water bodies listed were considered polluted, especially the most urbanized. Most of the voters use the lakes and creeks to some degree, especially Lake Travis and Lake Austin. A majority of the respondents utilize the various water bodies for some form of contact recreation, and thus the existing contact recreation standards and criteria are appropriate.

Problems Encountered

The study was found to be limited in some areas, due to funding constraints, equipment malfunctions, and lack of rainfall during the final months of the study. With respect to the latter, the pollutant loading data for Northwest Austin and Rollingwood sites were obtained for storms with runoff depths between 0.002 and 0.08 inch. Therefore, the effect of runoff volume on average pollutant concentration and unit loading (load per acre) was not fully quantified over the wide range of storms experienced in the Austin area.

As mentioned earlier, the evaluation of the Woodhollow Dam was not statistically valid, due to a lack of data. In view of this, a detailed cost/benefit analysis of BMP's was not done.

There were some reports of construction in the vicinity of the Rollingwood monitoring station during the early portion of the study. This site was not monitored long enough to allow an analysis of the Rollingwood data so as to isolate the effects of any such construction.

Sufficient data were not collected from the undeveloped watershed, Turkey Creek. Therefore, detailed quantification of stormwater runoff pollutant loads is limited to low and medium density.

The effects of storm loading on the lake water quality are not fully quantified. It would greatly add to the understanding of loadings and in-stream responses to have a synoptic quantification of tributary loads (especially Bull Creek) and more detailed receiving water analysis. Only two storm events were sampled for both lakes. This is insufficient for direct comparison. Further, since the study did not span a full year, it was not possible to observe seasonal variations.

No priority pollutant analysis of the water column was done.

Fecal coliform/fecal streptococcus ratios were not developed for the tributaries. This would have made an attempt at determining the source of the bacteria possible.

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RECOMMENDATIONS OF THE ADVISORY BOARD
FOR THE CITY OF AUSTIN
NATIONWIDE URBAN RUNOFF PROGRAM

Based on review of the "Final Report of the City of Austin Nationwide Urban Runoff Program," it is the recommendation of this Advisory Board that the City Council should adopt the following policy actions and take the necessary steps to address future research needs in the area of urban runoff pollution.

A. Policy

1) Retain watershed ordinances which incorporate nonstructural controls, because the study has indicated that they reduce overall pollutant loads to water bodies.

2) Begin a program of timely dissemination of accurate information about water quality to the public. This should be in conjunction with the news media, and when appropriate, should include advisories or warnings on the presence of significant levels of possible toxins, and any other data that is warranted.

3) Centralize water quality data bases and sampling in the Lake Austin and Town Lake watersheds.

4) Continue to develop and refine a comprehensive stormwater quality management plan to be implemented by the City. This should specifically include an expanded assessment of pollutant loads on streams and receiving waters, and which emphasizes the effects of structural controls. Such a water quality monitoring program should also evaluate the impact of urban runoff on area aquifers.

5) City Council should fund the implementation of such a program, and those research projects delineated in the next section.

B. Further Research

1) The stormwater management plan should include the following:

a) An in-depth pesticide analysis of the fish tissue from Austin area lakes is highly recommended. Certain pesticides have been detected in the fish tissue and sediments. It is important to discover and report the extent of the issue as soon as possible, and determine whether it constitutes a problem.

b) In any future study of the lakes, determine the fecal coliform/fecal streptococcus ratio of all bacteriological samples as it helps determine the origins of waterborne bacteria as likely being of either human or animal origin. Furthermore, a diversity index of both phytoplankton and

benthic communities is recommended as it helps detect the probability of degradation of aquatic populations.

c) A preliminary survey of "priority pollutants" of the water column of both lakes is needed. Currently no data exists for Lake Austin, and only one set of data is available for Town Lake.

d) Continue sampling at Woodhollow Dam and expand the monitoring at other structural controls to determine their effectiveness.

e) Do more water quality monitoring of streams in the Lake Austin watershed, especially the most highly developed ones like Dry Creek. Currently 70% of the watershed is not being monitored. Furthermore, so as to provide information for comparision purposes, more runoff data needs to be collected on an adequate "control" or natural condition watershed that is relatively undeveloped like Turkey Creek.

f) Determine what the storm loads are under those development/land use conditions, not yet monitored, especially high density residential and commercial areas.

g) Quantify the effects of storm loading on the lake water quality; i.e., quantify the effects of pollutant loading on Lake Ausitn from its tributaries.

h) Do a detailed cost/benefit analysis of 'best management practices' (BMP's) when sufficient data are obtained on the various structural control measures.

2) Perform an evaluation of State water quality standards to evaluate their adequacy for Austin and, if necessary, recommend alternative standards to the Texas Department of Water Resources.

LOCATION OF ACTIVE NURP PROJECTS

NATIONWIDE URBAN RUNOFF PROJECT

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NURP PROJECTS

1.DURHAM, NEW HAMPSHIRE	NH1
2.LAKE QUINSIGAMOND, MASSACHUSETTS	MA1
3.MYSTIC RIVER, MASSACHUSETTS	MA2
4.LONG ISLAND, NEW YORK	NY1
5.LAKE GEORGE, NEW YORK	NY2
6.IRONDEQUOIT BAY, NEW YORK	NY3
7.METRO WASHINGTON, D.C.	DC1
8.BALTIMORE, MARYLAND	MD1
9.MYRTLE BEACH, SOUTH CAROLINA	SC1
10.WINSTON-SALEM	NC1
11.TAMPA, FLORIDA	FL1
12.KNOXVILLE, TENNESSEE	TN1
13.LANSING, MICHIGAN	MI1
14.OAKLAND COUNTY, MICHIGAN	MI2
15.ANN ARBOR, MICHIGAN	MI3
16.CHAMPAIGN-URBANA, ILLINOIS	IL1
17.CHICAGO, ILLINOIS	IL2
18.MILWAUKEE, WISCONSIN	WI1
19.AUSTIN, TEXAS	TX1
20.LITTLE ROCK, ARKANSAS	AR1
21.KANSAS CITY, KANSAS	KS1
22.DENVER, COLORADO	CO1
23.SALT LAKE CITY, UTAH	UT1
24.RAPID CITY, SOUTH DAKOTA	SD1
25.CASTRO VALLEY, CALIFORNIA	CA1
26.FRESNO, CALIFORNIA	CA2
27.BELLEVUE, WASHINGTON	WA1
28.EUGENE, OREGON	OR1

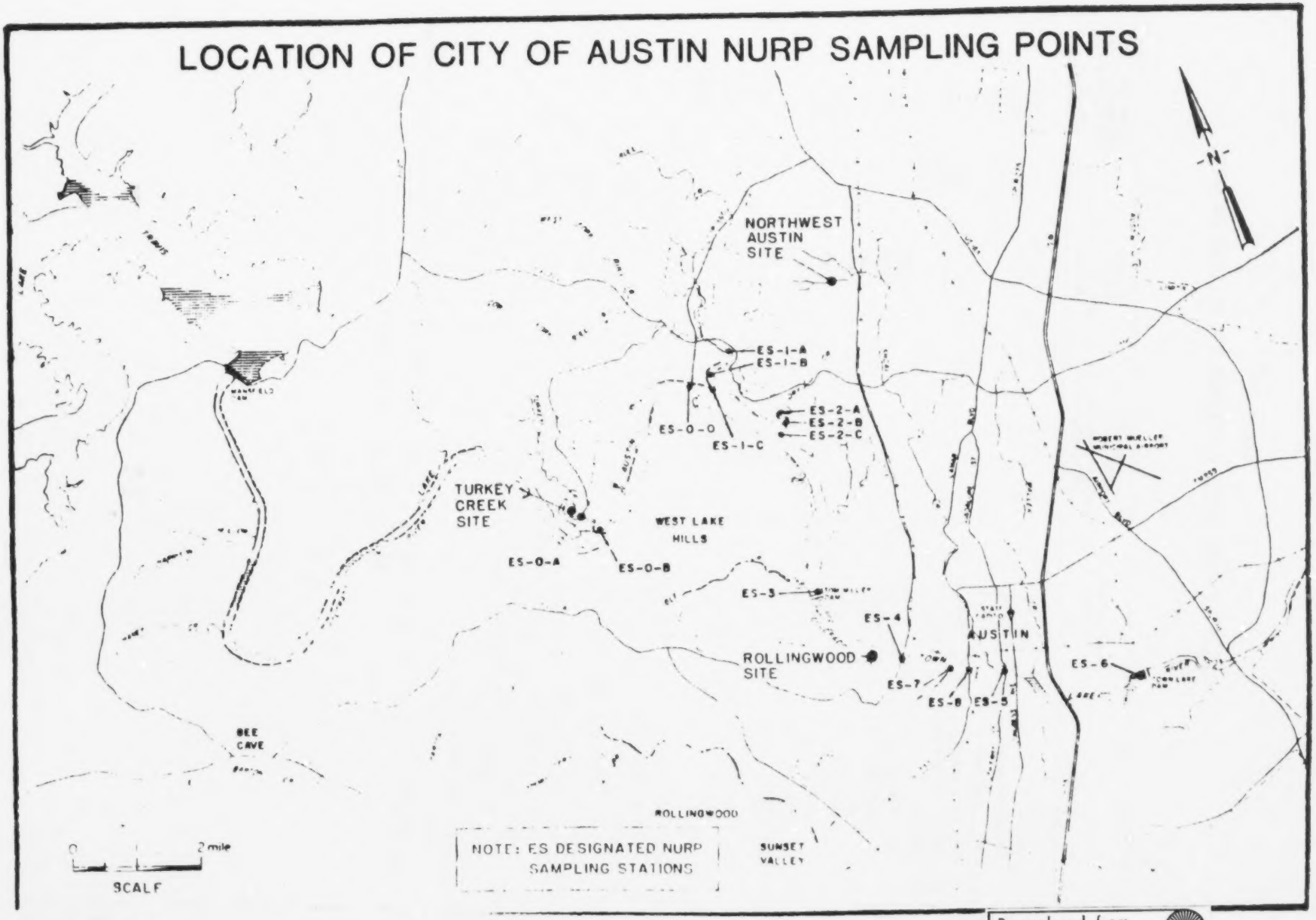

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TABLE 57

QUALITY CRITERIA FOR WATER AND ITS RELATED IMPACTS

Parameter	Drinking Water Standard (mg/l)	Freshwater Aquatic Life Standard (mg/kg tissue)	Allowable Average Daily Intake[a] (mg/day)	Protection of Aquatic Life Standard (µg/l)
pH[b]	5.0-9.0[c]	-	-	6.5-9.0[c]
Fecal Coliforms[d]	200.0[c,i]	-	-	14[c,j]
Ammonia-nitrogen	0.5[e]	-	-	20[c,k]
Nitrate-nitrogen	10.0[c]	-	-	-
Total Suspended Solids	-	-	-	-[c,l]
Metals:				
Arsenic	0.05[c]	-	0.70[f]	-
Cadmium	0.01[c]	-	0.018[f]	12[m,c]
Copper	1.00[c]	-	3.20[f]	-
Mercury	0.002[c]	1.009	0.03[f]	0.05[c]
Lead	0.05[c]	-	0.30[f]	30[e]
Zinc	5.00[c]	-	12.00[f]	-
Pesticides:				
DDD	-	5.00[h]	-	-
DDE	-	5.00[h]	-	-
DDT	-	5.00[h]	-	0.001[c]
PCBs	-	5.00[h]	-	0.001[c]

[a]Average daily intake that will not be harmful to a normal person.

[b]pH unit.

[c]Quality Criteria for Water (U.S. EPA, 1976).

[d]No./100 ml.

[e]Water Quality Criteria, 1972, National Academy of Sciences.

[f]Personal communication with Texas State Health Department (1982).

[g]Most recent U.S. FDA guideline for mercury in edible fish.

[h]Texas Department of Water Resources (Report 264, 1982).

[i]For bathing waters.

[j]For shellfish harvesting waters.

[k]As unionized ammonia.

[l]Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.

[m]For aquatic life exclusive of cladocerans and salmonid which are more sensitive.

TABLE 9

USGS ANALYSES OF FECAL COLIFORM CONCENTRATIONS
IN TOWN LAKE FOLLOWING RAINFALL EVENTS

Date of Sample	Fecal Coliform Colonies per 100 ml			Number of Days Between Sampling Date and Previous Rainfall	Previous Rainfall Depth (inches)
	Tom Miller Dam	Lamar Boulevard	Longhorn Dam		
2/03/75	60	120	460	0	0.7-0.9
6/12/75	84	140	290	2	0.3-1.0
8/12/75	6	69	72	8	0.1-0.9
1/06/76	9	88	16	13	1.0-1.7
4/20/76	240	960	2,500	2	2.8-5.2
9/01/76	8	10	520	0	0.0-0.5*
9/02/76	7	680	2,800	0	1.0-2.1
12/28/76	6	57	12	9	0.1-0.2
4/26/77	6	16	16	6	0.3-0.5
8/23/77	7	9	53	12	0.1-0.4
12/29/77	9	540	52	0	0.1-0.2**
4/10/78	280	2,800	3,800	0	1.2-2.6
7/18/78	4	38	84	40	0.1-0.4
10/16/78	20	31	6	13	0.0-0.4
2/07/79	9	39	64	1	0.3-0.5
5/29/79	16	140	180	1	0.1-0.2
8/22/79	8	37	120	3	0.1-0.2
7/27/79	680	9,900	12,000	0	4.0-4.4
3/03/80	6	82	8	3	0.1-0.3
3/28/80	220	4,600	2,000	1	2.8-2.9
5/19/80	44	140	200	1	0.1-0.2

*Rainfall occurred only in East Austin.

**0.2 inches of rain also had fallen on 12/28/77.

TABLE 10

FECAL COLIFORM CONCENTRATIONS IN DAVIS WTP INTAKE WATERS
FOLLOWING RAINFALL EVENTS

Month of Rainfall Event	Amount of Rainfall (inches)	Fecal Coliform Colonies Per 100 ml			
		Day Prior to Rainfall	Day of Rainfall Event	Day After Rainfall Event	Two Days After Rainfall Event
April, 1976	3.39	*	210	120	116
May, 1976	1.82	5	5	120	80
September, 1977	1.38	*	50	36	140
November, 1977	1.08	2	6	8	*
May, 1978	1.10	14	34	*	*
June, 1978	3.36	2	3	46	32
July, 1978	0.86	4	36	40	11
January, 1979	1.35	24	16	12	*
May, 1979	4.08	*	2	58	63
May, 1980	1.14	2	6	14	*
May, 1980	1.42	*	31	16	12

* No fecal coliform sample taken. Normal laboratory procedures at the Davis water treatment plant only permit coliform enumeration on Monday through Thursday of normal work week.

TABLE 21

SUMMARY OF INSTANTANEOUS POLLUTANT CONCENTRATIONS FOUND IN STORM RUNOFF

Parameter	Site*	High	Low	Median	Mean (Arithmetic)	Standard Deviation (Arithmetic)	Data Pts.
Acidity as $CaCO_3$ (mg_3/l)	H	18.0	<1.	6.6	8.0	4.30	51
	R	20.0	0.1	6.3	7.5	3.86	58
	Tb/Ts	16.0	4.0	10.8	11.3	3.27	24
Alkalinity as $CaCO_3$ (mg_3/l)	H	234.	36.	85.6	95.6	49.00	51
	R	192.	0.5	62.8	73.4	35.91	58
	Tb/Ts	264.	184.	219.2	219.0	15.55	23
Ammonia (mg/l)	H	5.90	0.09	1.2	1.40	0.89	84
	R	4.00	0.04	1.3	1.52	0.87	84
	Tb	1.61	0.39	0.8	0.86	0.33	23
	Ts	2.46	0.03	1.2	1.37	0.69	9
COD (mg/l)	H	754.	4.	46.1	68.	87.18	84
	W	4t.	E.	29.1	31.	10.18	23
	R	45[illegible].	E	61.4	84.	79.10	84
	Tb	3[illegible].	4.	15.5	18.	13.45	23
	Ts	15[illegible].	23.	44.7	57.	38.66	9
Hardness as $CaCO_3$ (mg_3/l)	H	30[illegible].	63.	124.0	136.	62.09	51
	R	264.	32.	88.2	97.	45.52	58
	Tb/Ts	24[illegible].	152.	202.4	204.	31.09	23
Nitrate-N (mg/l)	H	6.10	0.13	1.6	1.95	1.36	84
	W	3.0[illegible]	0.2[illegible]	1.0	1.23	0.77	23
	R	14.10	0.21	1.0	1.39	1.81	85
	Tb	0.32	0.07	0.13	0.14	6.54	23
	Ts	0.5[illegible]	0.11	0.25	0.28	0.16	9
TKN (mg/l)	H	30.0[illegible]	0.69	2.3	3.19	3.78	97
	W	3.83	1.08	2.3	2.48	0.94	26
	R	7.82	0.10	2.2	2.72	1.76	84
	Tb	1.97	0.75	1.2	1.27	0.32	23
	Ts	3.00	1.00	1.9	1.99	0.62	9
Total P (mg/l)	H	3.40	0.03	0.2	0.31	0.42	104
	W	0.37	0.08	0.2	0.22	0.05	34
	R	3.60	0.04	0.22	0.29	0.39	85
	Tb	0.31	<0.01	0.03	0.04	0.07	21
	Ts	0.24	<0.01	0.06	0.10	0.09	9
TSS (mg/l)	H	1,42[illegible].	1.	47.0	127.0	198.5	104
	W	17[illegible].	0.	26.3	36.6	35.8	34
	R	1,62[illegible].	1.	83.5	167.4	270.8	85
	Tb	9.	1.	2.5	3.4	2.6	24
	Ts	41[illegible].	9.	68.7	132.1	148.1	9
TDS (mg/l)	H	64[illegible].	83.	210.6	234.	115.52	91
	R	1,0[illegible].	13.	151.4	206.	223.11	85
	Tb/Ts	1,05[illegible].	226.	311.0	328.	144.67	33
TOC (mg/l)	H	270.0	2.9	13.3	18.9	29.34	90
	W	31.1	5.2	12.4	13.5	5.73	31
	R	44[illegible].0	7.2	21.2	32.5	51.69	82
	Tb	21.2	1.8	6.7	8.9	6.92	16
	Ts	51.9	9.2	17.3	19.6	12.82	9
Fecal Coliform (No./100 ml)	H**	47,0[illegible]	6.	1,422.	8,400.	12,300.	29
	R	224,[illegible]	4	706.	14,400.	52,500.	16
	Tb/Ts	1,50[illegible]	4	24.	142.	393.	14

* H = Hart Lane (Northwest Austin)

W = Woodhollow Dam (survey station with 24" pipeline closed)

R = Rollingwood

Tb = Turkey Creek background data

Ts = Turkey Creek storm data

** Includes data collected at Woodhollow Dam survey station.

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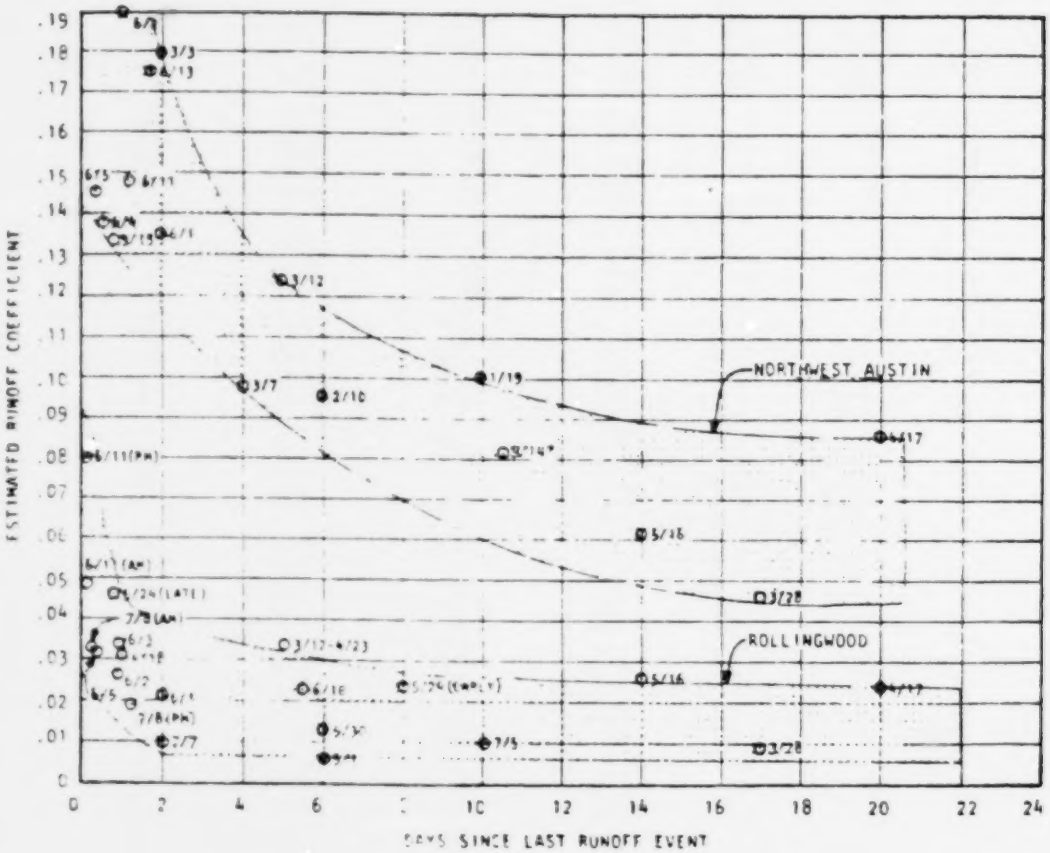
FIGURE 24

NORTHWEST AUSTIN AND ROLLINGWOOD SITES ESTIMATED RUNOFF COEFFICIENTS



NOTE: USED ONLY NURP RAIN GAUGE ON 9/15 AND 9/14 TO CALCULATE RUNOFF COEFFICIENTS BECAUSE USGS GAUGES REPORTED RAINFALL WHICH WAS CONSIDERABLY HIGHER THAN THE MEASURED RUNOFF VOLUMES WOULD HAVE INDICATED FOR THE NORTHWEST AUSTIN SITE.

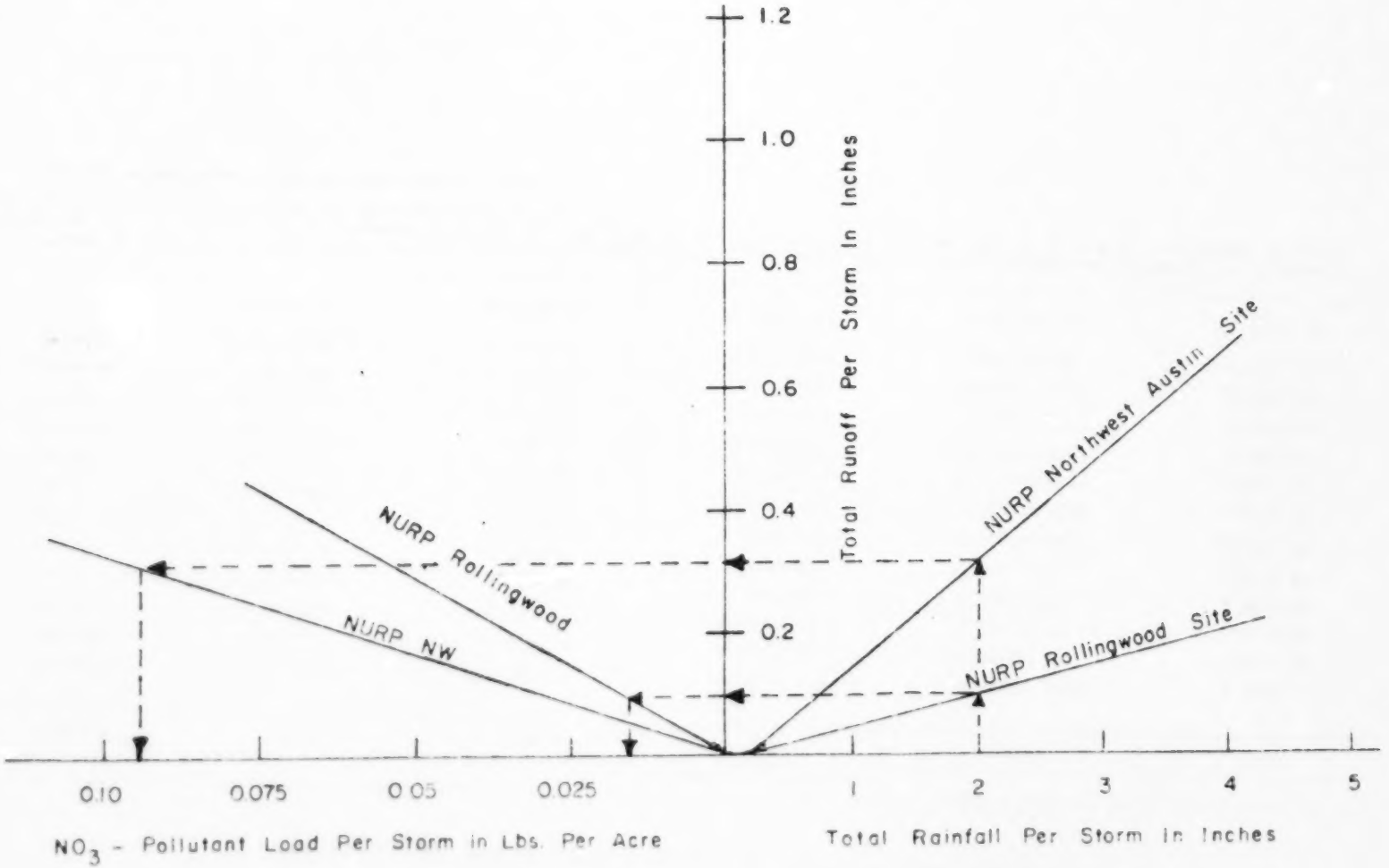
TABLE 31

ESTIMATED AVERAGE MONTHLY POLLUTANT LOADS FROM TEST WATERSHEDS

Month	Parameter in lbs/acre*				
	TOC	COD	NH_3-N	Total P	TSS
January	0.11/0.70**	0.40/2.20	0.008/0.038	0.0011/0.0078	1.58/3.73
February	0.24/1.40	0.84/4.21	0.018/0.071	0.0025/0.0147	3.48/7.09
March	0.11/0.63	0.41/2.07	0.008/0.037	0.0011/0.0076	1.51/3.56
April	0.21/1.21	0.76/3.90	0.016/0.068	0.0021/0.0141	2.92/6.65
May	0.27/1.70	0.95/5.27	0.02/0.091	0.0027/0.0187	3.82/8.93
June	0.25/1.45	0.90/4.63	0.019/0.081	0.0026/0.0167	3.50/7.88
July	0.12/0.61	0.45/2.25	0.008/0.042	0.0012/0.0088	1.47/3.96
August	0.16/0.84	0.61/3.03	0.011/0.056	0.0016/0.0118	2.00/5.31
September	0.27/1.56	1.18/4.96	0.02/0.087	0.0027/0.0179	3.76/8.46
October	0.25/1.43	0.92/4.79	0.018/0.086	0.0025/0.0178	3.36/8.26
November	0.15/0.85	0.55/2.89	0.011/0.052	0.0015/0.0108	1.96/5.00
December	0.15/0.85	0.53/2.74	0.011/0.048	0.0015/0.01	2.02/4.66
Total	2.29/13.23	8.50/42.94	0.168/0.757	0.0231/0.1567	31.38/73.52

*Based on predicted average runoff volumes and storm-average concentrations where the runoff coefficient was estimated from Figure 24 using the interval between storms presented in Table 30. The value of Y was taken as 1.2 and the value of E as 0.5. The number of storms per month was estimated based on the data presented in Table 30.

**No./No. = Rollingwood Site/Northwest Austin Site.



Storm Load – Runoff – Rainfall Relationship – NO_3

TABLE 34

REMOVAL OF POLLUTANT MASS
IN THE WOODHOLLOW DAM RETENTION BASIN

Date	Pollutant	Mass In (lbs)	Mass Out (lbs)
3/07/81*	COD	95.6	91.5
	TOC	20.0	24.8
	NH_3-N	3.4	2.5
	Total P	0.54	0.45
	TSS	122	41
9/14/81**	TOC	50.2	10.7
	Total N	19.49	3.56
	Total P	0.74	0.29
	TSS	479	73
9/15/81***	TOC	63.0	160.5
	Total N	29.56	28.93
	Total P	1.47	1.84
	TSS	244	544

*Hydraulic Detention = 15.5 hours.

**Hydraulic Detention = 20.5 hours.

***Hydraulic Detention = 3.6 hours.

TABLE 39

PRIORITY POLLUTANTS IN AUSTIN STORM WATER RUNOFF

Detected Parameter (ug/l)	Sample Number							
	H1050 pp*	H1050 pp (duplicate)*	H1401 pp	H1401 pp (duplicate)	R1701 pp*	R1701 pp (duplicate)*	R.401 pp	R2401 pp (duplicate)
Arsenic	<ND 5**	<ND 5**	3.3	4.6	4.3	4.1	<ND 5**	<ND 5**
Chromium	<ND 20**	<ND 20**	26	26	<ND 20**	<ND 20**	<ND 20**	<ND 20**
Copper	<ND 20**	<ND 20**	25	24	17.0	17	<ND 20**	<ND 20**
Lead	60.5	58.5	126	155	140.1	138.8	37.6	38.3
Selenium	<ND 5**	<ND 5**	<ND 5**	<ND 5**	11.3	12.5	<ND 7**	<ND 7**
Zinc	29.0	38.5	99	99	64	64	10	10
Phenol	8.0	-	4.0	-	-	-	-	-
Cyanide	5.0	-	2.0	-	-	-	-	-
Methylene chloride	ND	ND	ND	ND	452	624	269	178
4,4' DDD	ND	ND	<10	ND	ND	ND	ND	ND
4,4' DDT	ND	ND	ND	<10	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	14	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	ND	ND	ND	ND	ND	ND	ND	18

NOTE: If a compound is not listed, it was reported as "not detected".

H = Northwest Austin (Hart Lane) site and R = Rollingwood site.

*Indicates a "first flush" sample.

**Not detected at specified limit.

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TABLE 37

SUMMARY OF METALS ANALYSES PERFORMED ON RUNOFF SAMPLES

	Rollingwood				Woodhollow Dam				Northwest Austin			
	1	2	3	4	1	2	3	4	1	2	3	4
ES Metals I												
Arsenic	1/4	<30-70	<30	30	3/14	<30-70	<30	30	1/2	<30-40	<30	30
Copper	3/4	<5-11	7	5	5/14	<5-16	<5	5	2/2	16-160	88	5
Cadmium	0/4	<1	<1	1	1/14	<1-1.3	<1	1	0/2	<1	<1	1
Mercury	0/1	<5	-	5	0/1	<5	-	5	-	-	-	-
Lead	3/4	<50-340	130	50	1/14	<50-110	<50	50	2/2	140-890	515	50
Zinc	4/4	41-134	65	5	14/14	22-46	35	5	2/2	57-510	284	5
ES Metals II												
Arsenic	-	-	-	-	-	-	-	-	-	-	-	-
Copper	7/8	<5-42	11	5	2/2	8-15	11.5	5	4/5	<5-42	34	5
Cadmium	0/8	<5	<5	5	0/2	<5	<5	5	0/5	<5	<5	5
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Lead	6/8	<50-390	115	50	2/2	70-180	125	50	4/5	<50-270	100	50
Zinc	8/8	8-155	51	5	1/2	<5-22	-	5	5/5	15-100	52	5
Priority Pollutant Metals												
Arsenic	1/2	<5-4.3	-	5,1	-	-	-	-	1/2	<5-3.3	-	5,1
Copper	1/2	12-<20	-	5,20	-	-	-	-	1/2	<20-25	-	20
Cadmium	0/2	<5	<5	5	-	-	-	-	0/2	<5	<5	5
Mercury	0/2	<5	<5	5	-	-	-	-	0/2	<5	<5	5
Lead	2/2	37.6-140.1	89	10	-	-	-	-	2/2	60.5-126	93.3	10
Zinc	2/2	10-64	37	5	-	-	-	-	2/2	29-99	64	5
MDSD Special Metals												
Arsenic	0/4	<10	<10	10	0/1	<10	-	10	0/3	<10	<10	10
Copper	0/4	<20	<20	20	0/1	<20	-	20	3/3	30-80	40	20
Cadmium	1/4	<5-40	<5	5	0/1	<5	-	5	0/3	<5	<5	5
Mercury	0/4	<1	<1	1	0/1	<1	-	1	0/3	<1	<1	1
Lead	2/3	<40-130	120	40	1/1	80	-	40	3/3	210-320	220	40
Zinc	2/3	<10-70	40	10	1/1	5,760	-	10	3/3	80-160	100	10

KEY: Column 1 = number of samples above detection limit/total number of samples analyzed.

Column 2 = range of concentrations reported (µg/l).

Column 3 = median concentration value (µg/l).

Column 4 = detection limit (µg/l).

MDSD = U.S. EPA Monitoring and Data Support Division.

Priority Pollutant Metals - analysis performed by Spectrix Corporation in Houston, Texas.

TABLE 40

AMBIENT WATER QUALITY CONDITIONS IN
TOWN LAKE DURING PRELIMINARY SURVEY

Water Quality Parameters	Station Location		
	ES 4 Mopac Bridge	ES 5 South First Street Bridge	ES 6 Main Pool Near Longhorn Dam
Alkalinity, mg/l	138	140	144
BOD_5, mg/l	<1	<1	<1
COD, mg/l	23	11	4
Total Organic Carbon, mg/l	12.8	14.8	14.0
Total Kjeldahl Nitrogen, mg/l	1.03	0.97	0.95
Ammonia Nitrogen, mg/l	0.10	0.13	0.20
Nitrite Nitrogen, mg/l	<0.01	<0.01	<0.01
Nitrate Nitrogen, mg/l	0.26	0.32	0.35
Total Phosphorus, mg/l	0.02	0.03	0.03
Ortho-Phosphorus, mg/l	<0.01	0.01	0.01
Total Dissolved Solids, mg/l	293	337	376
Total Suspended Solids, mg/l	4	7	11
Mercury, mg/l	<0.0005	<0.0005	<0.0005
Zinc, mg/l	0.012	0.005	0.014
Cadmium, mg/l	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.02	<0.02	<0.02
Copper, mg/l	<0.02	<0.02	<0.02
Lead, mg/l	<0.05	<0.05	<0.05
Fecal Coliforms*, No./100 ml	2	4	6

*Fecal coliform numbers may be biased on the low side because of large serial dilutions used during laboratory sample preparation.

TABLE 41

AMBIENT WATER QUALITY CONDITIONS IN
LAKE AUSTIN DURING PRELIMINARY SURVEY

Water Quality Parameters	Station Location		
	ES-1 Bull Creek Confluence	ES-2 Dry Creek Confluence	ES-3 Main Pool Near Tom Miller Dam
Alkalinity, mg/l	138	134	136
BOD_5, mg/l	<1	<1	<1
COD, mg/l	57	76	8
Total Organic Carbon, mg/l	17.2	17.9	13.5
Total Kjeldahl Nitrogen, mg/l	0.95	0.94	1.07
Ammonia Nitrogen, mg/l	<0.01	0.15	0.20
Nitrite Nitrogen, mg/l	<0.01	<0.01	<0.01
Nitrate Nitrogen, mg/l	0.28	0.26	0.27
Total Phosphorus, mg/l	0.01	<0.01	<0.01
Ortho-Phosphorus, mg/l	0.01	<0.01	<0.01
Total Dissolved Solids, mg/l	326	322	382
Total Suspended Solids, mg/l	6	14	6
Mercury, mg/l	<0.0005	<0.0005	<0.0005
Zinc, mg/l	0.007	<0.005	<0.005
Cadmium, mg/l	<0.001	<0.001	<0.001
Arsenic, mg/l	0.03	<0.02	<0.02
Copper, mg/l	<0.02	<0.02	<0.02
Lead, mg/l	<0.05	<0.05	<0.05
Fecal Coliforms,* No./100 ml	3	6	5

*Fecal coliform numbers may be biased on the low side because of large serial dilutions used during laboratory sample preparation.

TABLE 55

WATER QUALITY CONDITIONS IN LAKE AUSTIN AFTER STORM EVENT 25 (7/05/81)

Sampling Date	Parameter	Station									
		ES-0-A	ES-0-B	ES-0-C	ES-1-A	ES-1-B	ES-1-C	ES-2-A	ES-2-B	ES-2-C	ES-3
7-6-81	Alkalinity (mg/l)	144	164	140	218	226	156	154	154	146	154
	BOD_5 (mg/l)	1	1	1	1	1	1	1	1	1	1
	COD (mg/l)	11	4	7	4	4	18	11	11	4	4
	TOC (mg/l)	15.3	6.4	6.5	8.4	7.6	5.4	4.9	5.3	4.4	4.5
	Nitrogen, ammonia (mg/l)	0.47	0.67*	0.52*	0.49	0.75*	0.73*	0.57*	0.57*	0.39	0.50
	Nitrogen, nitrate (mg/l)	0.13	0.11	0.14	0.58	0.59	0.28	0.49	0.34	0.21	0.11
	Nitrogen, nitrite (mg/l)	<0.01	0.01	<0.01	0.01	0.01	0.01	0.02	0.01	<0.01	<0.01
	Nitrogen, total (mg/l)	0.99	0.93	1.09	0.93	0.89	1.00	1.03	1.03	0.84	1.01
	Ortho-phosphorus, Diss. (mg/l)	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Phosphorus, total (mg/l)	0.03	0.03	0.03	0.03	0.05	0.03	0.06	0.06	0.01	<0.01
	Solids, Total Diss. (mg/l)	261	283	278	262	244	260	248	248	271	234
	Solids, Total Susp. (mg/l)	8	8	9	33	67	23	41	37	6	9
	Fecal Coliform (No./100 ml)	142	186	168	TNTC**	TNTC**	TNTC**	TNTC**	TNTC**	86	78
7-9-81	Alkalinity (mg/l)	140	168	136	212	214	174	176	164	156	142
	BOD_5 (mg/l)	2	1	1	1	1	1	1	1	1	1
	COD (mg/l)	4	4	4	4	29	11	4	11	7	7
	TOC (mg/l)	8.9	4.4	5.4	4.6	4.1	4.7	6.3	4.5	6.6	4.0
	Nitrogen, ammonia (mg/l)	0.43	0.45	0.11	0.31	0.09	0.14	0.20	0.10	0.02	0.10
	Nitrogen, nitrate (mg/l)	0.19	0.22	0.11	0.32	0.41	0.27	0.32	0.21	0.22	0.11
	Nitrogen, nitrite (mg/l)	<0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01	0.01	0.01	<0.01
	Nitrogen, total (mg/l)	1.25	1.37	1.42	1.26	1.33	1.24	1.53	1.42	1.60	1.35
	Ortho-phosphorus, Diss. (mg/l)	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Phosphorus, Total (mg/l)	<0.01	0.02	<0.01	0.03	0.03	0.02	0.05	0.03	0.03	<0.01
	Solids, Total Diss. (mg/l)	393	425	346	369	390	361	357	382	338	358
	Solids, Total Susp. (mg/l)	7	14	9	72	48	19	30	27	23	9
	Fecal Coliform (No./100 ml)	270	500	30	133	2,030	180	1,070	220	60	110

*Value exceeded the limitation of 0.5 mg/l.

**Too numerous to count.

TABLE 56

WATER QUALITY CONDITIONS IN TOWN LAKE
AFTER STORM EVENT 25 (7/05/81)

Sampling Date	Parameter	Station ES-4	ES-5	ES-6	ES-7	ES-P
7-6-81	Alkalinity (mg/l)	144	146	150	210	120
	BOD_5 (mg/l)	1	2	2	1	1
	COD (mg/l)	4	4	4	4	4
	TOC (mg/l)	2.4	4.4	4.5	3.0	7.0
	Nitrogen, ammonia (mg/l)	0.45	0.36	0.43	0.35	0.29
	Nitrogen, nitrate (mg/l)	0.22	0.16	0.22	0.86	0.81
	Nitrogen, nitrite (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrogen, total (mg/l)	0.99	1.10	1.17	0.76	1.05
	Ortho-phosphorus, Diss. (mg/l)	<0.01	<0.01	<0.01	<0.01	0.05
	Phosphorus, Total (mg/l)	<0.01	<0.01	0.03	0.03	0.03
	Solids, Total Diss. (mg/l)	446	413	374	362	418
	Solids, Total Susp. (mg/l)	6	11	17	25	6
	Fecal Coliform (No./100 ml)	*	221	TNTC**	TNTC**	TNTC**
7-9-81	Alkalinity (mg/l)	146	146	152	220	142
	BOD_5 (mg/l)	1	1	1	1	1
	COD (mg/l)	7	4	4	4	14
	TOC (mg/l)	5.2	4.4	3.7	1.7	3.6
	Nitrogen, ammonia (mg/l)	0.23	0.30	0.30	0.18	0.23
	Nitrogen, nitrate (mg/l)	0.27	0.25	0.23	0.84	0.29
	Nitrogen, nitrite (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrogen, total (mg/l)	1.44	1.44	1.36	1.20	1.33
	Ortho-phosphorus, Diss. (mg/l)	<0.01	<0.01	<0.01	<0.01	0.01
	Phosphorus, Total (mg/l)	0.03	0.03	0.02	0.01	0.03
	Solids, Total Diss. (mg/l)	345	337	333	251	301
	Solids, Total Susp. (mg/l)	12	6	3	26	11
	Fecal Coliform (No./100 ml)	2,160	150	460	910	870

*Atypical growth

**TNTC = too numerous to count

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TABLE 42

METALS CONCENTRATIONS IN LAKE AUSTIN AND TOWN LAKE

Station	Metals* (ppm)					
	Arsenic	Cadmium	Copper	Mercury	Lead	Zinc
Water Column						
ES-1	<0.01	<0.001	0.0024	0.0017	<0.001	<0.005
ES-2	<0.01	<0.001	0.0015	<0.0005	<0.001	<0.005
ES-3	0.047	<0.001	<0.001	<0.0005	<0.001	<0.005
ES-4	0.01	<0.001	<0.001	<0.0005	<0.001	<0.005
ES-5	<0.01	<0.001	<0.001	0.0011	0.0032	<0.005
ES-6	<0.01	<0.001	0.0026	0.0011	<0.001	<0.005
Sediments						
ES-2	-	0.054	-	<0.01	14.90	-
ES-3	-	0.045	-	<0.01	9.54	-
ES-4	-	0.212	-	<0.01	42.30	-
ES-5	-	0.019	-	<0.01	<0.10	-
ES-6	-	0.020	-	<0.01	0.40	-

*Survey conducted September 1981.

TABLE 43

ANALYSIS OF SEDIMENTS FROM TOWN LAKE

Parameter	Collection Site								
	4A	4B	4C	5A	5B	5C	6A	6B	6C
Percent Solid	61	58	54	58	62	61	72	68	66
Clay, percent	33.76	31.16	18.14	31.14	38.72	23.66	32.58	30.90	20.18
Sand, percent	16.85	20.75	24.20	5.95	21.40	12.65	11.20	28.10	17.25
Silt, percent	49.39	48.09	57.66	62.91	29.88	63.69	56.22	41.00	62.57
Volatile Fraction, mg/kg	84	101	111	81	72	82	49	58	90
Total Kjeldahl Nitrogen, mg/kg	56	4,300	4,200	2,700	2,700	2,600	1,700	1,900	2,400
Arsenic, mg/kg	5.8	12.5	17.4	0.4	5.1	11.8	11.3	10.3	9.7
Copper, mg/kg	19	17	21	26	24	27	36	35	50
Mercury*, mg/kg	0.78	0.05	1.3	0.37	0.18	0.35	0.08	1.5	0.12
Lead, mg/kg	120	49	136	123	158	109	148	150	183
Zinc, mg/kg	75	69	101	101	100	117	111	107	143
Cadmium*, mg/kg	4.1	0.08	3.7	1.9	3.2	0.9	3.3	2.6	3.1
DDE, ug/kg	24	91	92	47	56	71	46	58	5
DDD, ug/kg	5	96	97	35	31	45	35	63	5
DDT, ug/kg	5	124	92	43	37	79	13	19	5
Diazinon, mg/kg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2,4-D, mg/kg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2,4,5-T, mg/kg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

NOTE: Stations A,B, and C represent discrete samples taken at each monitoring site.

*Additional sample surveys indicated that these metals probably exist in the sediments at much lower concentrations (see Table 42).

TABLE 44

ANALYSIS OF SEDIMENTS FROM LAKE AUSTIN

Parameter	Collection Site								
	1A	1B	1C	2A	2B	2C	3A	3B	3C
Percent Solid	70	68	63	68	63	68	64	66	61
Clay, percent	26.20	34.84	16.48	19.04	28.54	35.88	24.83	16.92	48.06
Sand, percent	14.50	5.20	25.00	8.40	1.60	14.60	7.15	20.10	22.20
Silt, percent	59.30	59.96	58.52	72.56	69.86	49.52	68.02	62.98	29.74
Volatile Fraction, g/kg	49	52	63	55	60	64	59	49	80
Total Kjeldahl Nitrogen, mg/kg	1,500	1,700	2,500	2,000	3,300	1,200	2,400	1,700	2,600
Arsenic, mg/kg	4.3	6.7	5.8	3.9	8.0	6.7	7.1	2.0	6.8
Copper, mg/kg	13	17	17	15	16	20	18	19	19
Mercury*, mg/kg	0.03	0.03	0.03	0.10	3.7	0.09	0.84	0.03	0.12
Lead, mg/kg	45	81	76	64	79	65	74	73	67
Zinc, mg/kg	30	44	36	47	49	53	50	38	55
Cadmium*, mg/kg	1.4	2.3	2.6	2.0	2.6	2.3	2.8	3.4	3.4
DDE, µg/kg	108	<5	<5	97	63	23	<5	6	<5
DDD, µg/kg	75	<5	<5	101	63	11	<5	<5	<5
DDT, µg/kg	72	<5	<5	53	39	17	<5	<5	<5
Diazinon, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-D, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0 1
2,4,5-T, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

NOTE: Stations A,B, and C represent discrete samples taken at each monitoring site.

*The magnitude of these data are unusually high and don't correspond to information presented in the report entitled "Intensive Surface Water Monitoring Survey for Segment No. 1403, Lake Austin" TDWR, June 1976. Additional sample surveys indicated that these metals probably exist in the sediments at much lower concentrations (see Table 42).

TABLE 45

ANALYSIS OF TOXIC ORGANICS IN FISH TISSUE FROM TOWN LAKE

Species Common Name: Scientific Name	Weight (g)	Tail Length (cm)	Organics (µg/kg) in Tissue DDD	DDE	DDT	PCBs
Rio Grande Perch #1[3]: Cichlasoma cyanoguttatum	173	19.1	380	880	260	<100
Rio Grande Perch #2[3]:	172	19.1	1,500[4]	3,600[4]	790[4]	<100
Redbreasted Sunfish #1[1]: Lepomis auritus	236	20.7	160	670	380	<100
Redbreasted Sunfish #2[1]:	194	20.3	140	1,500	46	<100
Redbreasted Sunfish #3[2]:	91	17.2	350	1,400	290	<100
Bluegill Sunfish #1[2]: Lepomis macrochirus	165	-[5]	100	380	150	<100
Bluegill Sunfish #2[3]:	94	15.9	79	490	79	<100
Redear Sunfish #1[3]: Lepomis microlophus	150	20.3	40	380	150	<100
Redear Sunfish #2[3]:	150	19.7	160	560	60	<100
Largemouth Bass: Micropterus salmoides	428	31.8	40	370	40	<100

[1]ES-4 site.

[2]ES-5 site.

[3]ES-6 site.

[4]Sum of the DDT residue concentrations exceed the U.S. Food and Drug Administration cumulative standard of 5,000 µg/kg.

[5]Composite sample of several fish approximately 5 cm in length used in analysis.

TABLE 46

ANALYSIS OF TOXIC ORGANICS IN FISH TISSUE FROM LAKE AUSTIN

Species Common Name: Scientific Name	Weight (g)	Tail Length (cm)	Organics (µg/kg) in Tissue			
			DDD	DDE	DDT	PCBs
Bluegill Sunfish #3[2]: Lepomis macrochirus	86	16.5	27	250	10	<100
Bluegill Sunfish #4[2]:	66	14.6	20	180	<10	<100
Bluegill Sunfish #5[3]:	102	17.2	73	380	120	<100
Redear Sunfish #3[1]: Lepomis microlophus	160	20.3	280	870	200	<100
Redear Sunfish #4[1]:	185	23.5	24	87	30	<100
Redear Sunfish #5[2]:	76	15.9	85	230	10	<100
Redear Sunfish #6[2]:	59	15.3	20	120	<10	<100
Redear Sunfish #7[3]:	55	15.3	19	84	38	<100
Longnose Gar #1[2]: Lepisosteus osseus	398	58.4	310	2,700	200	<100
Longnose Gar #2[2]:	295	58.4	40	560	<10	<100

[1]Fish taken from ES-1 site.

[2]Fish taken from ES-2 site.

[3]Fish taken from ES-3 site.

TABLE 47

ANALYSIS OF METALS IN FISH TISSUE FROM TOWN LAKE

Species Common Name: Scientific Name	Metals (µg/kg) in Tissue					
	As	Cd	Cu	Hg	Pb	Zn*
Rio Grande Perch #1: Cichlasoma cyanoguttatum	40	2.0	55	<17	500	9.9
Rio Grande Perch #2:	60	2.5	75	<17	<50	9.1
Redbreasted Sunfish #1: Lepomis auritus	60	<0.5	1,400	<17	<50	12.0
Redbreasted Sunfish #2:	105	<0.5	960	<17	<50	21.0
Redbreasted Sunfish #3:	25	<0.5	1,200	<17	200	13.0
Bluegill Sunfish #1: Lepomis macrochirus	<20	<0.5	1,800	<17	<50	14.0
Bluegill Sunfish #2:	<20	<0.5	14	<17	<50	7.5
Redear Sunfish #1: Lepomis microlophus	55	<0.5	56	<17	<50	14.0
Redear Sunfish #2:	45	<0.5	1,100	<17	<50	20.0
Largemouth Bass: Micropterus salmoides	<20	<0.5	40	<17	<50	9.9

*Concentration in mg/kg.

TABLE 48

ANALYSIS OF METALS IN FISH TISSUE FROM LAKE AUSTIN

Species Common Name: Scientific Name	Metals (µg/kg) in Tissue					
	As	Cd	Cu	Hg	Pb	Zn*
Bluegill Sunfish #3[2]: Lepomis macrochirus	<20	6.0	740	<17	<50	7.9
Bluegill Sunfish #4[2]:	30	<0.5	95	38	<50	1.7
Bluegill Sunfish #5[3]:	83	<0.5	60	<17	<50	14.0
Redear Sunfish #3[1]: Lepomis microlophus	40	<0.5	110	<17	<50	16.0
Redear Sunfish #4[1]:	35	<0.5	50	<17	<50	25.0
Redear Sunfish #5[2]:	30	<0.5	25	<17	<50	26.0
Redear Sunfish #6[2]:	185	13.0	1,200	<17	<50	14.0
Redear Sunfish #7[3]:	65	<0.5	25	30	<50	20.0
Longnose Gar #1 : Lepisosteus osseus	<20	4.5	1,500	<17	<50	7.8
Longnose Gar #2:	20	<0.5	85	<17	<50	10.0

[1]Fish taken from ES-1 site.

[2]Fish taken from ES-2 site.

[3]Fish taken from ES-3 site.

*Concentration in mg/kg.